MIDWEST CHP APPLICATION CENTER

In Partnership with the US DOE

combined heat & power in wastewater treatment plants

Rochester Wastewater Reclamation Plant
2,000 kW CHP Application

Project Profile

Quick Facts

Location:
Rochester, Minnesota

Facility Type:
Wastewater Treatment

Plant Capacity:
23.85 million gallons per day

Prime Mover Fuel Type:
Digester Gas or Natural Gas

Prime Mover Type:
Two dual-fuel engines (1,000 kW each)

Electric Generating Capacity:
2,000 kW

Heat Recovered from the Engines:
2.6 to 9.0 MM Btu/h

Implementation Cost:
$4 million ($2,000/kW)

Energy Savings in 2007:
$564,398

Began Operations:
1,400 kW in 2002 and 2,000 kW in 2008

Anaerobic Digesters:
Two continuous mix digesters (1.85 million gallon each)

Rochester Wastewater Reclamation

Project Overview

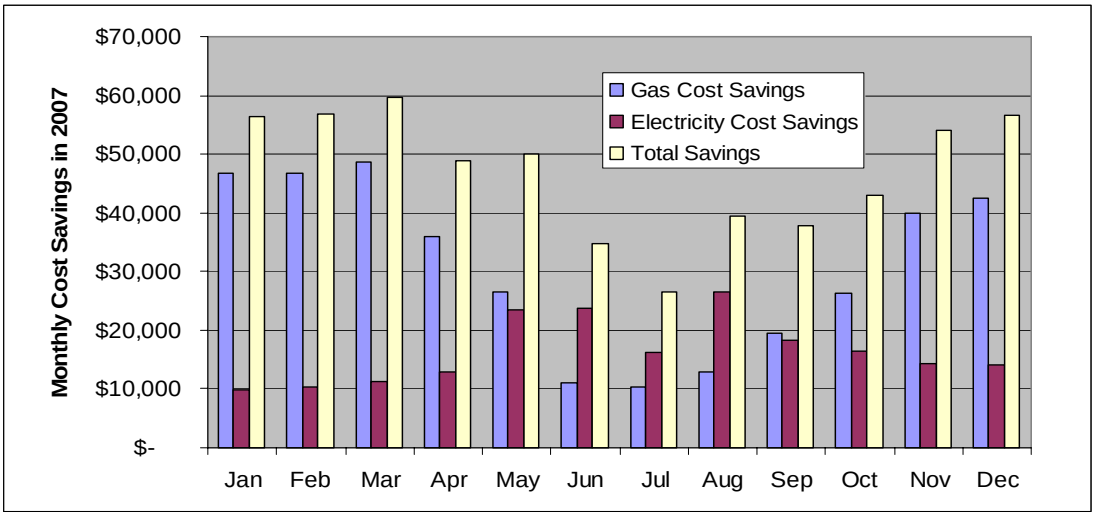
The Rochester Wastewater Reclamation Plant has been successfully operating a CHP system since 1982. In a two-phase project initiated in 2002 and completed in 2008, the original 800 kW CHP plant (Two 400 kW reciprocating engines) was upgraded to a 2,000 kW CHP plant that consists of two 1000 kW Waukesha engines. These engines are turbo-charged, lean-burn, 20% more efficient than the older engines and have dual-fuel capability for operating on either digester gas (biogas) or natural gas. The wastewater reclamation plant can process up to 23.85 million gallons per day (MGD) and uses two anaerobic digesters to treat the sludge. In 2007, the digesters produced approximately 338,000 cu ft/day of biogas containing 66% methane. This volume and quality of biogas is sufficient to produce 700 to 850 kW of electric power (depending on the time of the year) from the CHP system. At this capacity up to 4.5 MMBtu/hr of heat is recovered (from the engine jacket and exhaust gases) in the form of hot water (180°F-190°F) that is utilized for keeping the anaerobic digesters at optimum operating temperature and for providing space heating in the buildings at the facility. In 2007, the CHP system saved $564,398 in energy cost for the City of Rochester: $197,453 in electric energy and $336,945 in natural gas costs. The full generation capacity of 2,000 KW is utilized when backup power is needed for operating critical units, during utility grid power outages, by using natural gas or the biogas produced plus that stored in a 50-ft diameter biogas storage tank.

Reasons for CHP – A WWTF Owner's Perspective:

- Provides two solutions in one package:
  - Emergency backup power source
  - Reduction in the cost of purchased energy from utilities
- Provides measurable payback period
- Improves public relations because of reduced environmental emissions and use of renewable energy (biogas) source

Anaerobic Digestion

All wastewater treatment/reclamation plants produce organic sludge that requires treatment prior to its disposal. The treatment can be aerobic (in the presence of oxygen) or anaerobic (in the absence of oxygen). The anaerobic digestion process breaks down the organic waste contained in the sludge in a controlled, oxygen free environment. The process produces several outputs, a sludge that is ready for land application, a liquid high in nutrient content (mainly Nitrogen) that must be further treated, and a biogas that contains approximately 66% methane. The biogas is a valuable fuel that can be utilized (after some clean up) to displace natural gas in boilers for heating, in engines for distributed generation (including CHP), flared (not recommended with the high cost of energy), or cleaned up to utility grade gas and injected into the natural gas pipelines (an expensive option). At the Rochester facility, the biogas is utilized in the CHP system to produce electricity and heat, and when whether conditions dictate (very cold winter months) the biogas is utilized in boilers to produce the larger volume of required heat.



System Operations/Additional Information

- Two main anaerobic digesters (3.7 million gallon capacity) have a detention time of 34 days, are maintained at 98°F, and produce about 3.0 cu ft of biogas per gallon of sludge.
- Heat is recovered from the engine-jacket water (~ 2.5 MMBtu/h per engine) as well as the engine exhaust gases (~ 2 MMBtu/h per engine)
- One 50 ft.-diameter spherical gas storage tank (208,000 cu ft) is used for storing compressed (46 psig) biogas at high-pressure. During electric utility outages, the CHP system can be operated on either natural gas or the biogas stored in the sphere plus the biogas produced by the operating digesters.
- A helpful feature of the CHP system at the plant is that its controls are integrated with the plant SCADA system for monitoring and control.
- During winters, a greater financial savings can result, as shown in the above chart, from reducing the operating time and/or capacity of the CHP system and using some of the biogas as a direct fuel into the existing boilers. This operational characteristic applies in very cold climates such as Minnesota.
- The project has been successful because of the cooperation between the city personnel and design professionals from Integrated Engineering and Black & Veatch.

"We are very pleased with the operation of the CHP system. It allows the city to utilize the renewable biogas produced at the treatment plant for energy cost savings while also providing a source of emergency power. The system is also environmentally friendly because it eliminates flaring of the digester gas to the atmosphere."

Chet Welle
Assistant Plant Manager, Wastewater Reclamation Plant Wastewater Superintendent

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